DOCTORAL SCHOOL OF INFORMATION SCIENCE AND TECHNOLOGY

Training Plan

Approved by DSC:	November 4, 2024
Approved by UDHC:	December 16, 2024
Effective date:	December 17, 2024
Responsible for maintenance:	Head of the DS

TABLE OF CONTENTS

1. The elements of the PhD course and the stages of the training

The elements of the PhD course are the studies, the research activity, the reports and the teaching activity. These activities are controlled by the Doctoral School of Information Science and Technology (later DS) and the fulfilments are approved by giving credits.

The training has two stages:
- study-research stage (4 semesters, 120 credits)
- research-dissertation stage (further 4 semesters, further 120 credits)

In the training 240 credits have to be gained by

a) acquiring at least 48 credits of required course material in the study-research stage,
b) publishing – at least 110 credits from which at least 30 credits in the study-research stage,
c) reporting - at least 55 credits from which at least 15 in the study-research stage,
d) at least 6 credits by visiting events regarding the doctoral action (visiting a Comprehensive Exam, a home defense, a final defense (viva)), which contains 2 credits by visiting a Comprehensive Exam in the study-research stage,
e) the remaining 21 credits can be gained by teaching or by an activity supporting the doctoral education.

1.1. Competences

Our aim is that our graduated PhD students should have the competences as follows:

a) knowledge

The PhD student is aware of the general principles of IT technologies globally as well as in coherence.

He/she knows the subject, the general and the specific features of his/her research area as well as its directions and boundaries, agreed and disputed interrelations.

She has firm knowledge about the interrelations, theories and the terminologies of other sciences' research fields.

He/she extends his/her knowledge regarding his/her research field in an analyzing way.

He/she has the right mathematical and linguistic knowledge to be able to evaluate and to publish the data and result of his/her research.

He/she is aware of the research-methodology knowledge which is essential for the independent research in IT.

He/she knows and understands the interrelations, theories and terminologies of IT.

b) abilities

He/she is able to

- recognize the basic IT principles manifested in sociological and natural phenomena.
- to define the scientific background of the phenomena
- to recognize and to phrase the IT problems regarding these phenomena

He/she is able to plan and implement new projects, new work phases independently within his/her research area.

He/she is capable of creative analysis, of phrasing complex, special interrelations in a different point of view, furthermore, he/she is capable of evaluating and critical activity.

He/she is able to elaborate previously unknown methods of theoretical questions.

He/she is capable of recognizing the problems of his/her profession and he/she has the necessary theoretical and practical background to solve them.

He/she is able to discover and connect information occurring in IT although they seem to be remote. In the meanwhile he/she is able to recognize the important, decisive and relevant points of view while evaluating the research results.

He/she is capable of analyzing, of evaluating critically, scientifically his/her own and somebody else's research results.

He/she is capable of knowledge transfer to expert as well as to on-experts, and of participating in disputes and discussions.

He/she is capable of written and oral communication as well as of national and international cooperation.

He/she is able to summarize, to present his/her knowledge and research results. He/she is able to use the frequent means of publication (composing articles, books, case studies).

c) attitudes

His/her special characteristics are creativity, flexibility, problem recognizing and solving features, intuition, thoroughness, data processing feature, decisiveness.

He/she aims at identifying, defining unknown, unsolved scientific questions.

He is committed to his/her profession and accepts the necessity of the hard work.

He/she is open to new technologies, to learning new research areas, to transferring knowledge and to incorporation the determining elements into his/her R&D work.

He/she accepts the right criticism as well as others' professional arguments.

He/she committed to scientific cooperation on national as well as international level.

He/she aims to balancing the proportion of the individual and the teamwork.

He/she is characterized by independent and deep scientific work, he/she is open to the teamwork and to support others' work.

He/she strives for the social presentation of research results, monitors and takes into account the possible social, environmental and ethical effects of research.

d) autonomy and responsibility

He/she undertakes to answer the ethical questions of his/her profession.

He/she can be engaged in scientific disputes.

He is committed to care about nature.

He/she is creative and initiates new solutions.

1.2. Working plan of the students

The PhD program is carried out by individual curriculum. The curriculum has to be prepared in the first semester by the help of the supervisor by observing the rules of the DS, and it has to be sent to the e-mail address di@mik.uni-pannon.hu. The working plan has to be approved by the Disciplinary Doctoral and Habilitation Council (DDHC).

a) The working plan has to contain those subjects which the student wants to attend in order to fulfil the study requirements. Students can attend any

courses which are announced by the Doctoral School of Information Science and Technology (DS) or any other doctoral school in the field of IT. Courses from similar subject areas (e.g. computer science, mathematics, engineering) can be attended as well with the agreement of the supervisor and that of the DDHC. Students can (should) register for courses announced at foreign universities.

In case of all subjects points as follows have to be provided

- title of the course
- name of the tutor
- place of the announcements (university, doctoral schools or major)
- number of credits
- its schedule

The courses announced by the doctoral schools have to be represented on the homepage of the doctoral school (http://mik.uni-pannon.hu/di) together with the tutor's contacts and with the curricula.

The working plan also includes the research plan, which includes the research objective, schedule, planned study tours, and cost plan.

b) The working plan has to be submitted
   - electronically to the e-mail address (di@mik.uni-pannon.hu) of the doctoral school (in pdf) with the student's signature and the supporting signature of the supervisor

c) The research plan is approved by the DDHC till the beginning of the second semester at the latest.

2. Educational part of the PhD course

Courses announced by the doctoral school are grouped into subject fields (major subjects) as follows:

1. Digital reality
2. Dynamic systems and control
3. Discrete mathematics and optimization
4. Image and signal processing
5. Artificial intelligence
6. Medical and health informatics

Each subject field has a syllabus which is vital for fulfilling the requirements of the theoretical part of the Comprehensive Exam. The courses associated to a subject field prepare students for the theoretical part of the Comprehensive Exam. The list of subjects of the DS is contained in Appendix no. 1 of the Training Plan.

The DDHC accepts only those major subjects at the registration for the Comprehensive Exam, from which the doctoral student has successfully completed at least 3 subjects.

A list of recommended external subjects is associated to each subject fields (see Appendix no.1). These external subjects are accepted with 8 credits automatically similarly to those announced by the DS.

Subjects announced in an external doctoral program, other than the recommended external subjects, can also be taken if the doctoral student requests it in writing from the head of the DI, and his/her supervisor supports the request with a signature, and it is accepted by the DDHC. The request must contain:

- subjects title
- name of the tutor
- place of the course (university, doctoral school)
- syllabus.

All the subjects worth equally 8 credits. Students must fulfil at least 48 credits in the study-research stage of the study.

No study credits can be received by fulfilling subjects in the research-dissertation stage. Exception can be made by the permission of the head of the DS in case of international PhD courses (e.g. Summer School).

3. Independent research activity

This phase is the most important part of the doctoral study.

Credits can be received by the publication activity as follows (at least 110 credits):

a) An article published in an international journal having ISSN number, registered in SCI in English language worth 50 credits each.
b) An article published in an international journal having ISSN number in English language worth 20 credits each.
c) Conference presentation in English at an international conference with a complete; 4 page long proceedings worth 20 credits each.

d) Conference presentation in English at an international conference with an abstract worth 10 credits each.

In the lack of the resignation statement of the co-author the credits will be divided among the non-foreigner authors having no PhD degree.

The DS can accept the credits if the relevant publication is registered in the MTMT database, and it is uploaded onto data sheet of the student at www.dokori.hu

4. Reports and teaching activity

4.1. Compulsory reports (55 credits)

PhD students must present their progress in each semester orally and in writing as well. The DS gives credits for fulfilling the reports as follows:

in the first three semesters: 5-5 credits
from the fifth till the eighth semesters: 10-10 credits
in the 4th semester the student does not participate at the semester report, it is replaced by the Comprehensive Exam.

In the research-dissertation stage the successful home defense or the final defense (viva) results in the automatic acceptance of the semester report.

4.2. Study credit by teaching

Maximum 11 credits can be given to students for teaching activity (contact lessons, test-supervision, test-correction, training, seminar, laboratory, thesis consultation), maximum 6 credits can be given in each semester.

Students cannot be obliged to do teaching. The teaching activity is evaluated either by the head of the department or by the instructor responsible for the lecture, he/she proposes the credit.

Fulfilling 14 contact lessons (1hour/week) means 2 credits.

4.3. Activities assisting the doctoral education

Maximum 10 credits can be given to students for activities assisting the doctoral education (being a secretary at home defenses, at final defenses, at comprehensive exams, at PhD presentations or organizing workshops), but maximum 5 credits can be given in each semester.

The activities assisting doctoral education carried out by the students are certified by the head of the DS who proposes the number of credits. A certified activity worth 5 credits.

4.4. Visiting any doctoral action

In the first, study-research stage of the training students need to visit at least one Comprehensive Exam after registering to a 2 credit subject titled ”visiting a Comprehensive Exam”. The visit is justified by the attendance register.

In the second, research-dissertation stage students need to visit a home defense and a viva justified by an attendance register after registering to a 2 credit subject titled ”visiting a home defense and to a 2 credit subject titled “visiting a viva”.

5. Model curriculum

subject/ activity	total credit	semester 1	semester 2	semester 3	semester 4	semester 5	semester 6	semester 7	semester 8
education (M) at least 48									
courses (M)	48	8+8	8+8	8+8					
reports (M) 55									
reports (M)	55	5	5	5	-	10	10	10	10
teaching/other (O) max 27									
teaching (O)	11		6		5				
assisting (O)	10				5	5			
visiting (M)	6		2		2			2	
publications (M) at least 110									
SCI article	50							50	
other	60	10		20	10		20		
altogether	**240**	**31**	**29**	**41**	**22**	**15**	**30**	**62**	**10**

M: mandatory, O: optional

6. Comprehensive Exam

The conditions of letting a student take the Comprehensive Exam are as follows:

- accomplishing at least 95 credits in the first 4 semesters including at least 30 credits for publications and 48 credits for the educational part as described in the training plan of the DS,
- accomplishing the semi-annual reports in the first three semesters, the "Visiting the Comprehensive Exam" course (except for the students participating in the individual training, whose student status emerges by applying for the Comprehensive Exam and by being accepted).

The Comprehensive Exam is public, and it is taken in front of a committee. The Committee includes at least 3 members, one-third of the members are not employed by the institute. The chairman of the committee is a full professor or a professor emeritus or a researcher, instructor having a Doctor of Science title. All members of the committee have a scientific degree. The supervisor is allowed to be present as an observer at the non-public discussion of the committee. The supervisor sends the assessment of the student to the chairman of the committee electronically at least one week prior the exam.

The Comprehensive Exam consists of two parts:

- theoretical part – the theoretical knowledge of the student is measured,
- thesis part – the scientific progress of the student is measured.

The student takes exams in two subjects in the theoretical part:

- one in a major subject, whose list can be found in the doctoral school's training program titled "Educational part of the PhD part" and on the homepage of the DS, and
- one in a minor subject, which can be chosen from the list of the subjects in the DS, or in the field of informatics announced by the any accredited doctoral school in IT. The minor subject cannot be chosen from the subject group of the selected major subject.

The candidate participating in the organized training must have successfully completed at least three courses from the major subject of the Comprehensive Exam.

In the second part of the Comprehensive Exam the examinee has to present his/her knowledge about the literature, the research results, the research plan for the second stage of the doctoral training and the schedule of preparing the thesis and publishing the results have to be presented. The lecture touches upon the significances of the scientific results, upon its innovative content, upon its research technology motivation if relevant and its practical applicability of the results. The examinee has to submit the summary of his/her results and the publications to the committee electronically at least one week prior the exam.

The members of the examination committee evaluate the theoretical and the thesis part separately. The Comprehensive Exam is successful if the majority of the committee members evaluate both parts successful. In case of an unsuccessful exam the examinee can repeat the exam once more in the current exam period.

A record with textual evaluation has to be prepared about the Comprehensive Exam. The result of the exam has to be announced on the day of the oral exam.

The result of the Comprehensive Exam cannot be included in the final ranking of the doctoral degree, but it is a prerequisite of entering the second phase of the training.

List of Abbreviations

DS	Doctoral School of Information Science and Technology
DDHC	Disciplinary Doctoral and Habilitation Council of Information Science and Technology
IT	information technology
MTMT	Hungarian Scientific Bibliography - Magyar Tudományos Művek Tára
UDHC	University Doctoral and Habilitation Council

Implementation of the training plan

In the case of the training started after September 1, 2023, these modifications will take effect immediately. The Training Plan accepted on October 11, 2022 applies to doctoral students starting their training before September 1, 2023, with the addition that doctoral students can also take the new major subjects and subjects created in this training plan.

Appendix 1: Subjects of the Doctoral School of Information Science and Technology

Major subjects (main research topics):

1. Artificial intelligence
   responsible instructor: K. Hangos (DSc), coordinator: Á. Vathy-Fogarassy
2. Digital reality
   responsible instructor: P. Baranyi (DSc), C. Sik-Lanyi (DSc)
3. Discrete mathematics and optimization
   responsible instructor: G. Dósa (DSc), Z. Tuza (DSc)
4. Dynamic systems and control
   responsible instructor: K. Hangos (DSc), F. Hartung (DSc), A. Magyar (DSc), M. Pituk (DSc)
5. Image and signal processing
   responsible instructor: C. Sik-Lanyi (DSc), Z. Kató (DSc), G. Simon (DSc), coordinator: L. Czúni
6. Medical and health informatics
   responsible instructor: F. Bari (DSc), coordinator: Z. Juhász (PhD), I. Vassányi (PhD)

Subjects:

1) **Artificial intelligence**
   a) Advanced metaheuristic algorithms
      (responsible instructor: Á. Vathy-Fogarassy, T. Dulai)
   b) Deep learning and its applications
      (responsible instructor: Á. Vathy-Fogarassy)
   c) Engineering applications of artificial intelligence
      (responsible instructor: K. Hangos)
   d) Generative networks and transformers
      (responsible instructor: Á. Vathy-Fogarassy, T. Dulai)
   e) Intelligent control systems II
      (responsible instructor: K. Hangos)
   f) Learning algorithms of machine vision
      (responsible instructor: L. Czúni)
   g) Machine learning for predictive analytics
      (responsible instructor: Á. Vathy-Fogarassy)
   h) Reinforcement learning and its applications
      (responsible instructor: Á. Vathy-Fogarassy, T. Dulai)

   Recommended external subject:
   - –

2) **Digital reality**
   a) Cognitive Aspects of Virtual Reality i
      (responsible instructor: P. Baranyi)
   b) Cognitive theories in User Interfaces
      (responsible instructor: C. Sik-Lanyi)
   c) Colour perception and colour design
      (responsible instructor: C. Sik-Lanyi)
   d) Serious games and applications
      (responsible instructor: C. Sik-Lanyi)

   Recommended external subject:
   - –

3) Discrete mathematics and optimization

a) Analysis and synthesis of process systems
(responsible instructor: B. Bertók)
b) Global Optimization
(responsible instructor: T. Csendes)
c) Graph coloring
(responsible instructor: Z. Tuza)
d) Hypergraphs
(responsible instructor: C. Bujtás)
e) Integer and Mixed-Integer Programming
(responsible instructor: G. Dósa)
f) IT Tools and Techniques for Process Optimization
(responsible instructor: B. Bertók)
g) Linear and nonlinear programming
(responsible instructor: T. Holczinger)
h) Scheduling and bin packing
(responsible instructor: G. Dósa)
i) Stochastic programming
(responsible instructor: C. Fábián)

Recommended external subject:

- Advanced optimization (SZTE, responsible instructor: Dr. B. G.-Tóth)
- Applied Optimisation and Game Theory (VITMD097, BME, responsible instructor: Dr. T. Cinkler)
- Packing type problems and algorithms (SZTE, responsible instructor: Dr. J. Balogh, Dr. J. Békési)

4) Dynamic systems and control

a) Computer Controlled Systems II
(responsible instructor: K. Hangos, A. Magyar)
b) Control of nonlinear systems
(responsible instructor: K. Hangos, A. Magyar)
c) Controller Design Methods
(responsible instructor: A. Magyar)
d) Delay differential and difference equations and their applications
(responsible instructor: M. Pituk)
e) Discrete and continuous dynamical systems
(responsible instructor: M. Pituk)

f) Discrete event and hybrid dynamical systems
(responsible instructor: K. Hangos, A. Magyar)
g) Dynamic modelling for control and diagnosis
(responsible instructor: K. Hangos)
h) Intelligent Control Systems II
(responsible instructor: K. Hangos)
i) Numerical analysis
(responsible instructor: F. Hartung)
j) Parameter estimation and filtering of dynamical systems
(responsible instructor: K. Hangos, A. Magyar)
k) Partial differential equations and infinite dimensional dynamical systems
(responsible instructor: F. Hartung)

Recommended external subject:

- Analysis and control of nonlinear molecular processes (PPKE Roska Tamás Doctoral School of Sciences and Technology, responsible instructor: Dr. G. Szederkényi)
- Analysis of Matrices (BME, VIMAD569, responsible instructor: Dr. P. P. Pach)
- Modern Control Theory I (BME, VIFOD053, responsible instructor: Dr. B. Lantos)
- Modern Control Theory II (BME, BMEKOKAD002, responsible instructor: J. Bokor)

5) Image and signal processing

a) Advanced image processing techniques
(responsible instructor: L. Czúni)
b) Colour perception and colour design
(responsible instructor: C. Sik-Lanyi)
c) Digital image processing
(responsible instructor: L. Czúni)
d) Digital signal processing and its applications
(responsible instructor: G. Simon)
e) Learning algorithms of machine vision
(responsible instructor: L. Czúni)

Recommended external subject:

- Computer vision (SZTE, responsible instructor: Dr. Z. Kató)

6) Medical and health informatics

a) Clinical imaging
(responsible instructor: F. Bari)
b) GPU Programming
(responsible instructor: Z. Juhász)
c) Medical data modelling and analysis
(responsible instructor: I. Vassányi)
d) Modeling in Biomedicine
(responsible instructor: F. Bari)
e) Neuroscience Fundamentals
(responsible instructor: Z. Nagy)
f) Public health and health informatics
(responsible instructor: I. Kósa)
g) Signal processing in biomedicine
(responsible instructor: Z. Juhász)

Recommended external subject:

- Biostatistics (SZTE, responsible instructor: Dr. K. Boda)

7) other subjects

a) Mathematical Statistics
(responsible instructor: É. Orbán-Mihálykó)
b) Parallel Numerical Algorithms
(responsible instructor: Z. Juhász)
c) Theory of computation II
(responsible instructor: I. Heckl)